ANNUAL RESEARCH REPORT
FY 2009
January 2010

1. **Title:**

Demographic Characteristics and Ecology of Northern Spotted Owls (*Strix occidentalis caurina*) in the Southern Oregon Cascades.

2. **Principal Investigators and Organizations:**

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3. **Study Objectives**:

a. Estimate the population parameters (fecundity, survival rates, and annual rates of population change) of northern spotted owls on the Rogue River- Siskiyou and Fremont-Winema National Forests.

b. Examine diet, nesting habitat, and interspecific interactions of spotted owls .

c. Communicate results to other researchers examining spotted owl ecology throughout the Pacific Northwest.

4. **Potential Benefit or Utility of the Study**:

Studying the population biology, foraging ecology, and prey ecology of spotted owls will increase our understanding of factors affecting spotted owl populations. This study offers insights into how conservation can enhance or maintain habitat while concurrently addressing the validation and effectiveness monitoring requirements of the Northwest Forest Plan (1994). The Southern Oregon Cascades Study Area is one of five study areas in Oregon that are part of the Effectiveness Monitoring Program for Spotted Owls in the Northwest Forest Plan (Lint et al. 1999).

5. **Study Description and Survey Design:**

The design of this project follows the framework of a demographic study, a collection of known owl sites within a bounded area. This study gathered information on survival rates, reproductive rates, annual rate of population change, and other population characteristics of adult and subadult owls (Forsman et al. 2009). The study utilized a sample of northern spotted owls within Late-Successional Reserve (LSR), Matrix Land-use Allocations (LUA)(USDA and USDI 1994) and Congressionally Reserved Wilderness Areas (CRWA).

6. Study Area

The Southern Cascades Study Area incorporates approximately 2,230 km^2 of federally managed forest land. The area is geographically situated on lands administered by the Rogue River-Siskiyou National Forest (High Cascades Ranger District) and the Fremont-Winema National Forest (Klamath Ranger District) (Figure 1). The study area occupies the southern terminus of the Oregon Cascades including portions of both the western and eastern provinces. Landforms are primarily volcanic in origin and consist of plateaus and moderately dissected terrain (USDA and USDI 1994). The study area lies within the Mixed-Conifer, *Abies concolor*, *Abies magnifica* var. *shastensis*, and *Tsuga mertensiana* zones at elevations ranging from 900-2000 meters (Franklin and Dyrness 1973).

The Southern Cascades Spotted Owl Study Area was established in 1990 as one of the eight long-term monitoring sites in the Effectiveness Monitoring Program for Spotted Owls for implementation of the Northwest Forest Plan (Lint et al. 1999). The total number of surveyed spotted owl sites has varied over the years. There are 89 sites within the boundaries of the current study that have been surveyed continuously from 1992 to 2009 and a total of 169 sites were surveyed in 2009.

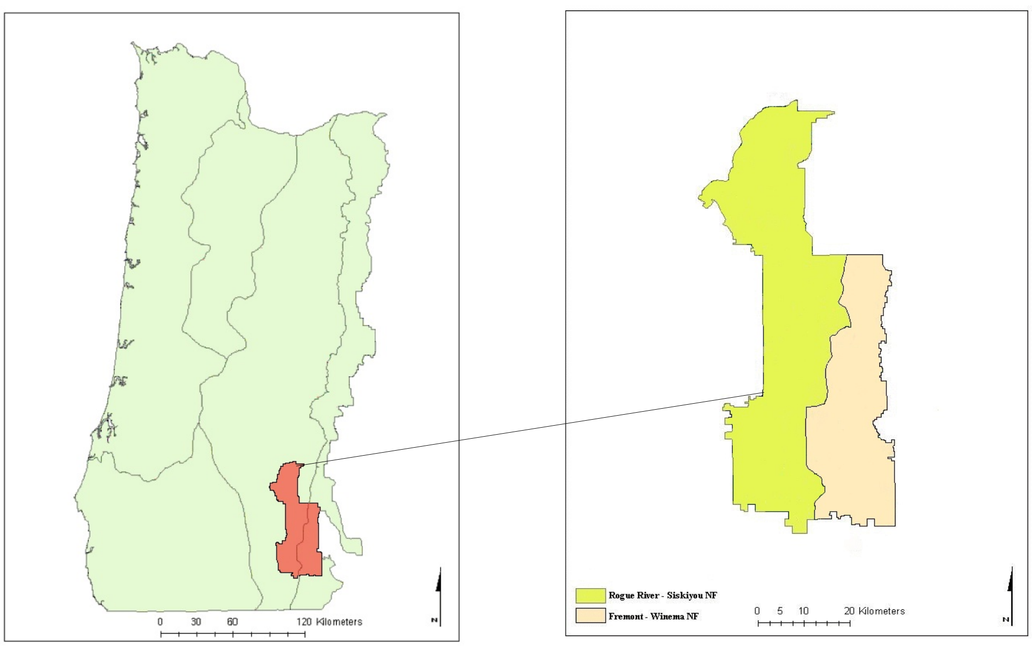

Figure 1. The Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009.

An important component of the Southern Cascades Northern Spotted Owl Study Area is the Late-successional Reserves: Rogue-Umpqua Divide (LSR 225), Middle Fork (LSR 226), Dead Indian (LSR 227), Clover Creek (LSR 228), and Sevenmile Creek (LSR 229). Of these, Rogue-Umpqua Divide, Middle Fork, and Dead Indian are large encompassing 16,050, 20,080, and 41,310 ha., respectively, and projected to support 15-20 pairs of owls (USDA 1998). Clover Creek and Sevenmile Creek LSRs are smaller, incorporating 1,130 and 3,710 ha. (USDA 1997). The LSRs are situated entirely within the study area. Dead Indian LSR spans the crest of the southern Oregon Cascades and is jointly administered by the Rogue River-Siskiyou and Fremont-Winema National Forests. Three Congressionally Reserved Wilderness Areas are also located within the study area. Owl territories were found in the Sky Lakes (45,800 ha.), Mountain Lakes (9,300 ha.) and a portion of the Rogue-Umpqua Divide Wilderness Areas (2,064 ha.) (Figure 2).

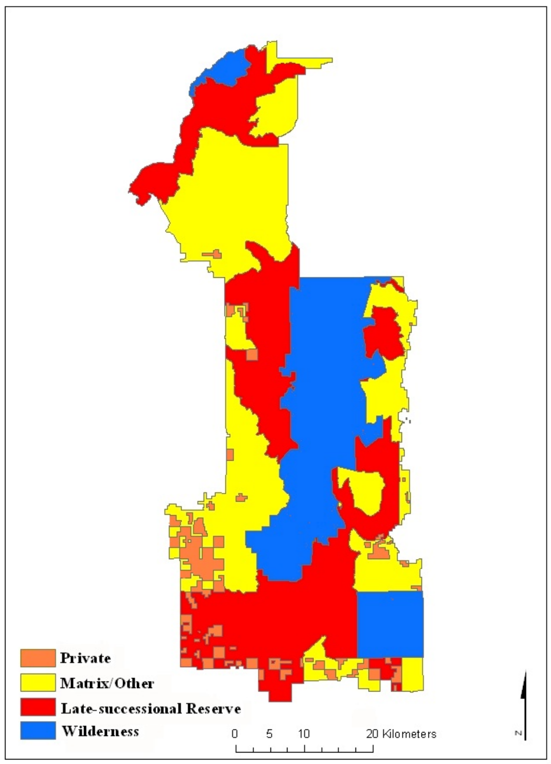

Figure 2. Land-use Allocations and owl sites within the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009.

7. **Research Accomplishments:**

Site Occupancy

Spotted owls occupied 74 of the 169 sites we visited in 2009 (Figure 3). Among the sites that were surveyed, 57 were occupied by pairs, 9 more than in 2008. There were 4 sites with single owls in 2009 and 13 sites where owls were detected but social status was not determined (Table 1). The lowest percentage of sites occupied by spotted owls on the study area (43.8) was observed in 2009 ($\bar{x}$ = 72.7%, SE = 3.34, n = 20). There were 89 sites with continuous survey effort between 1992 and 2009, and 38% were occupied by banded spotted owls reflecting a continuing decline over the years of the study ($\bar{x}$ = 57.5%, SE = 2.41, n = 18) (Figure 4).

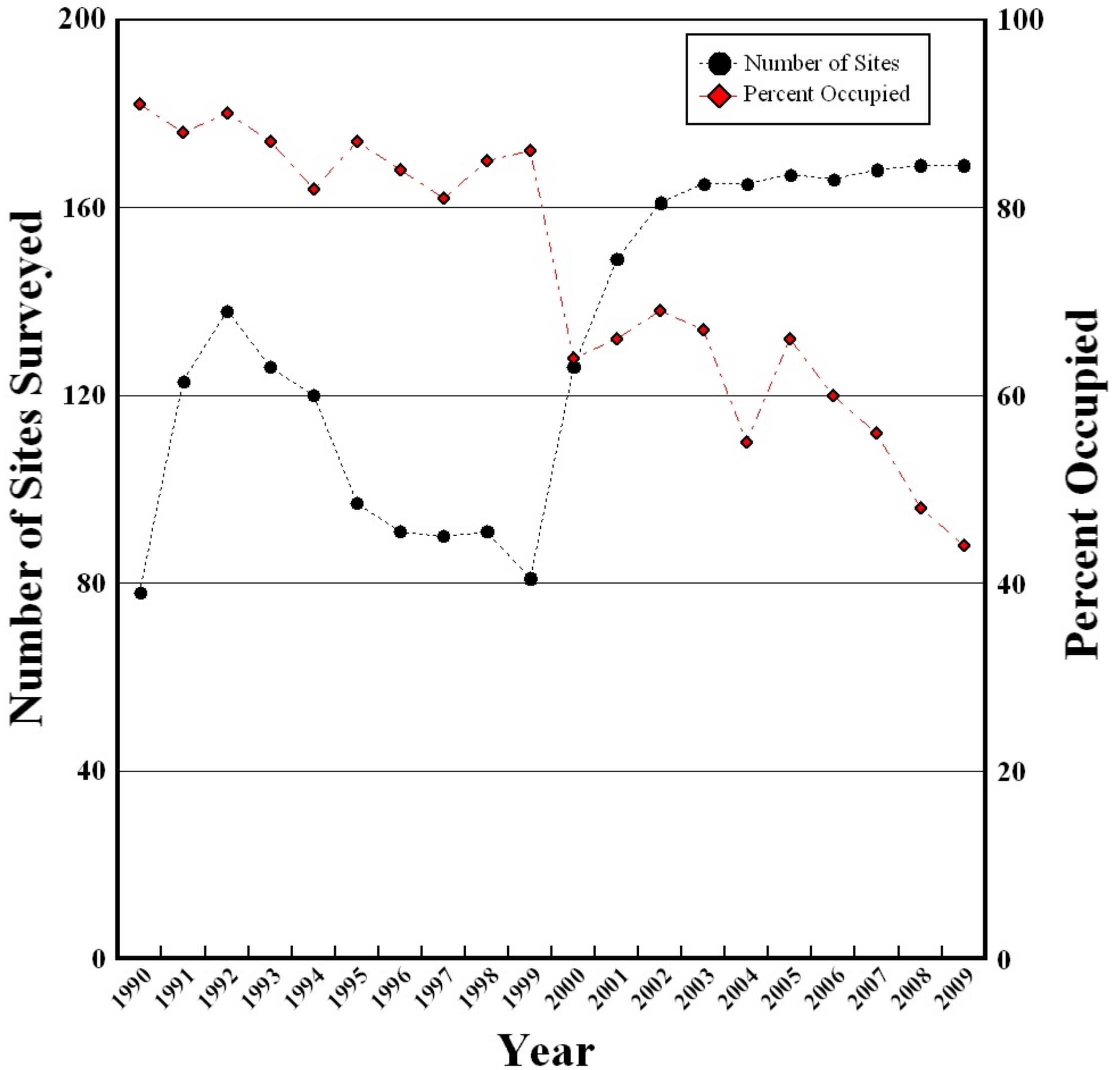

Figure 3. Annual number of sites surveyed to protocol and the percentage of occupied sites on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009.

Table 1. Number of northern spotted owl sites surveyed and their respective occupancy on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009[a].

Year	# Sites Surveyed[a]	# Sites w/ Pairs[a]	# Sites w/ Single Owls[a]	# Sites w/ Social Status Unknown[b]	Total Occupied Sites	# of Sites Unoccupied[c]	% Sites Occupied
1990	78	54	6	11	71	7	91
1991	123	81	5	22	108	15	88
1992	138	107	3	14	124	14	89
1993	126	78	9	22	109	17	86
1994	120	80	4	14	98	22	81
1995	97	62	8	14	84	13	87
1996	91	65	4	7	76	15	84
1997	90	58	4	11	73	17	81
1998	91	67	2	8	77	14	85
1999	81	58	7	5	70	11	86
2000	126	55	10	16	81	45	64
2001	149	80	1	18	99	50	66
2002	161	83	11	17	111	50	69
2003	165	91	5	14	110	55	67
2004	165	73	1	17	91	74	55
2005	167	87	7	17	111	56	66
2006	166	76	9	15	100	66	60
2007	168	79	4	11	94	74	56
2008	169	48	10	23	81	88	48
2009	169	57	4	13	74	95	44

[a] All sites which were surveyed to protocol; status as determined by protocol (Forsman 1995).
[b] Sites with a response by a male and/or female that did not meet pair or single status with ≥3 night visits.
[c] A minimum of 3 nighttime visits without a response was needed to infer unoccupied status.

Spotted owls were detected at 6 Wilderness, 48 LSR, and 20 Matrix sites in 2009 (Table 2). The percentage of sites occupied by owls in Wilderness decreased from 50% in 2008 to 33% in 2009, while the percentage of sites occupied by pairs decreased substantially (39 vs. 22%). The percentage of sites occupied by owls in the LSRs increased between 2008 and 2009 (46 vs. 49%), and the percentage of sites occupied by owl pairs also increased (27 vs. 37%). In the Matrix lands the percentage of sites occupied by owls decreased sharply in 2009 (38%) compared to 2008 (51%), while the percentage of sites occupied by owl pairs increased slightly (32 vs. 28%). The percentage of occupied sites with owl pairs increased in the LSRs (58 vs. 75%) and Matrix (56 vs. 85%) from 2008 to 2009 but decreased in the Wilderness (77 vs. 67%) (Figure 5).

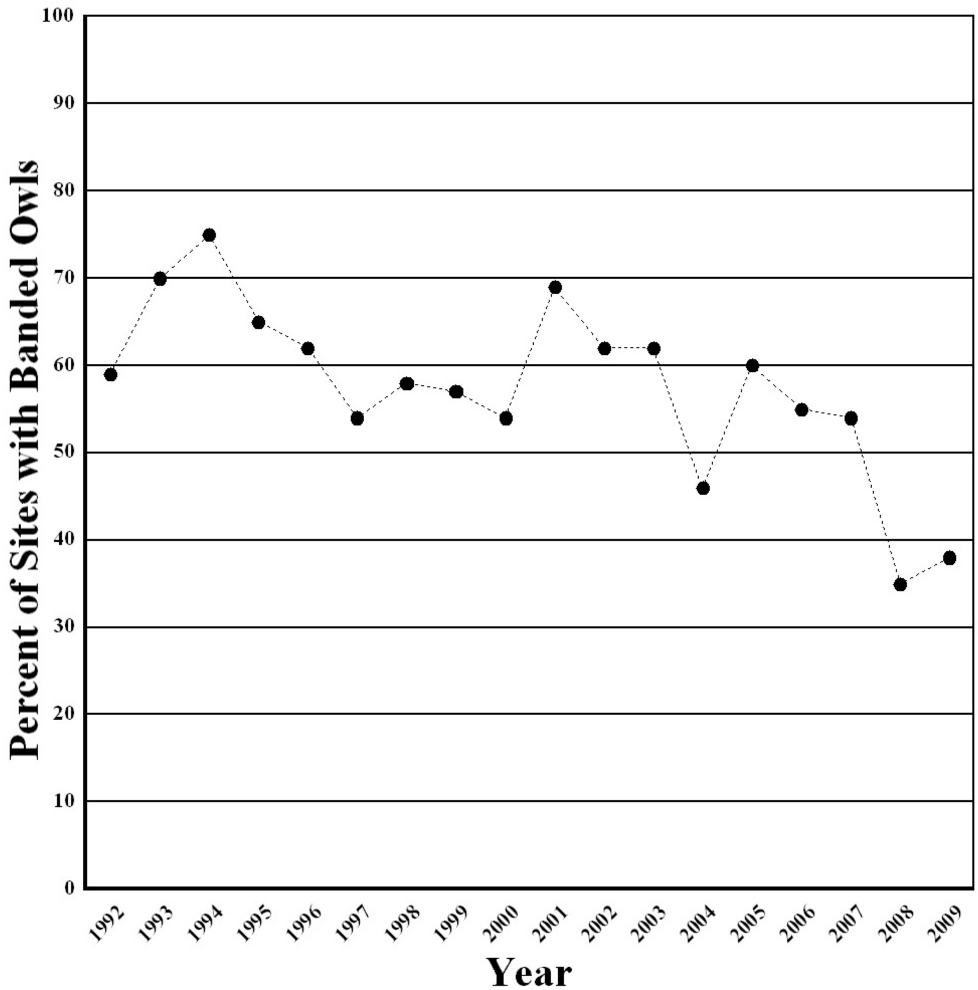

Figure 4. Annual percentage of sites surveyed that were occupied by banded spotted owls for 89 sites with continuous survey effort on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1992-2009.

The number of spotted owl pairs located in 2009 at the five LSRs was similar to most previous years. There were 15 owl pairs located in the Rogue-Umpqua Divide LSR ($\bar{x}$ = 11.9, SE = 0.73; n = 13; min. = 7, max. = 15). There were 12 pairs located in the Middle Fork LSR, twice as many as were located in 2009 ($\bar{x}$= 11.8, SE = 0.72, n = 13; min. = 6, max. = 16). In the Dead Indian LSR, 9 pairs were found in 2009 ($\bar{x}$ = 14.3, SE = 1.19, n =13; min. = 7, max. = 20). No owl pairs were located at the Sevenmile Creek LSR ($\bar{x}$ = 2.92, SE = 0.33, n = 13; min. = 0, max. = 4) or the Clover Creek LSRs ($\bar{x}$ = 0.83, SE = 0.21, n = 10; min. = 0, max. = 2) during the 2009 breeding season.

Table 2. Number of spotted owl sites surveyed to protocol and their respective occupancies by Land-use Allocation on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2009[a] .

Land-Use Allocation[b]	Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown	Total Occupied Sites	# Sites Unoccupied	% Sites Occupied
Matrix								
	1997	28	20	0	4	24	4	86
	1998	24	18	0	1	19	5	79
	1999	20	17	0	2	19	1	95
	2000	38	17	1	5	23	15	61
	2001	46	22	1	5	28	18	61
	2002	50	24	4	7	35	15	70
	2003	52	28	0	6	34	18	65
	2004	53	22	0	8	30	23	57
	2005	53	28	1	5	34	19	64
	2006	53	23	0	4	27	26	51
	2007	53	23	3	2	28	25	55
	2008	53	15	4	8	27	26	51
	2009	53	17	1	2	20	33	38
LSR								
	1997	53	34	3	6	43	10	81
	1998	58	40	2	7	49	9	84
	1999	52	37	6	2	45	78	87
	2000	79	32	9	9	50	29	63
	2001	86	49	0	12	61	25	71
	2002	94	51	6	10	67	27	71
	2003	95	52	4	6	62	33	65
	2004	95	42	0	9	51	44	53
	2005	96	51	4	9	64	32	67
	2006	96	45	8	10	63	33	66
	2007	98	47	1	9	57	41	58
	2008	98	26	5	14	45	53	46
	2009	98	36	2	10	48	50	49
Wilderness								
	1997	9	4	1	1	6	3	67
	1998	9	9	0	0	9	0	100
	1999	9	4	1	1	6	3	67
cont.								

Land-Use Allocation[b]	Year	# Sites Surveyed	# Sites w/ Pairs	# Sites w/ Single Owls	# Sites w/ Social Status Unknown	Total Occupied Sites	# Sites Unoccupied	% Sites Occupied
CWRA								
	2000	9	6	0	2	8	1	89
	2001	17	9	0	1	10	7	59
	2002	17	8	1	0	9	8	53
	2003	18	11	1	2	14	4	78
	2004	17	9	1	0	10	7	59
	2005	18	8	2	3	11	5	71
	2006	17	8	1	1	10	7	59
	2007	17	9	0	0	9	8	53
	2008	18	7	1	1	9	9	50
	2009	18	4	1	1	6	12	33

[a] See Table 1 for column heading definitions.

[b] See the Northwest Forest Plan (1994) for a description of Matrix and LSR Land-use Allocations.

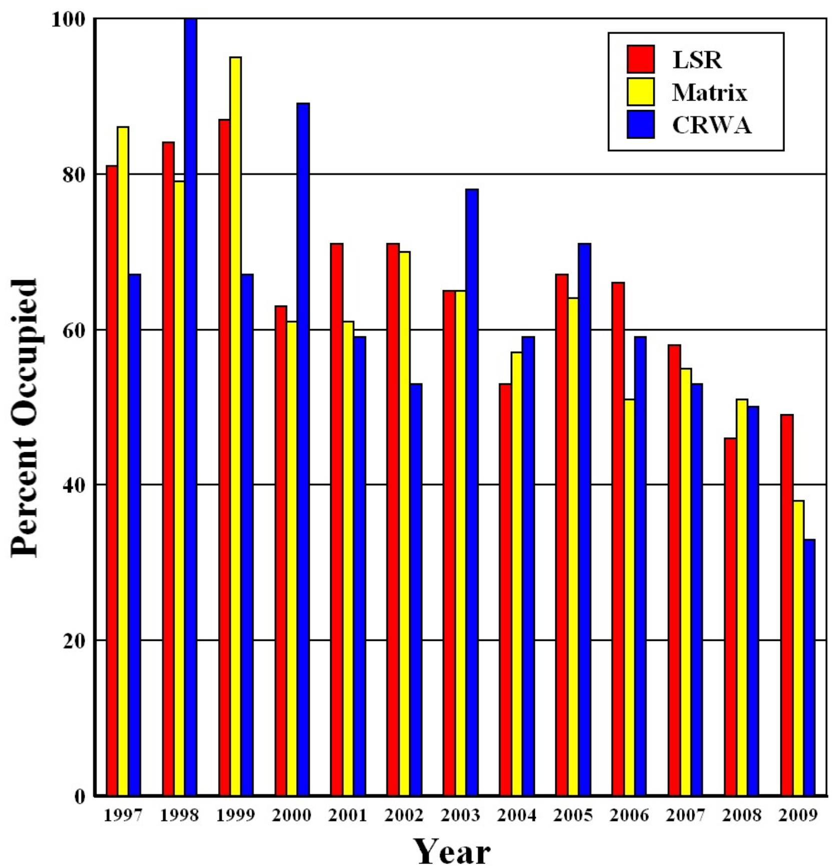

Figure 5. Percentage of sites surveyed to protocol that were occupied by northern spotted owls by Land-use Allocation on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2009.

Age and Sex Composition

A minimum of 132 non-juvenile owls were detected in 2009 which was similar to 2008. Of the owls which we could assign to an age class, 98.3% were adults (≥3 years old) and 1.7% were subadults (Table 3). We could not ascertain the age of 11% of the study population, which was less than that for most years ($\bar{x}$ = 18.8%, SE = 3.02, n = 20). The majority of unknown aged owls represented auditory detections usually during nighttime surveys without visual observation (Table 3).

On average 54% of the study area population has been composed of males, and males constituted a majority of the owls detected (51%) in 2009. In 2009, 2% of the study sample was composed of subadults, which equaled the average representation of subadults for all years combined. During the course of the study, there have been fluctuations in the number of subadults in the sample (min.= 2; max. = 18). Modeling the binary data using logistic regression in PROC GENMOD (SAS Institute 2008) suggested there was evidence of a difference in the number of males and females relative to the representation of adults and subadults [Akaike Weight (w_i)= 0.4265, 95% CI = (0.0684, 0.6715)] (Table 3 and 4) (Akaike 1973). The data were weakly supportive of models with a linear or pseudo-threshold time trend of increasing numbers of subadults and of subadult females compared to subadult males; however, the confidence intervals of the parameters both overlap 0 [95% CI= (-0.0099, 0.0182) and 95 % CI = (-0.0858, 0.1370), respectively] (Burnham and Anderson 2002, Anderson 2008) (Table 4).

Table 3. Age and sex composition of northern spotted owls detected on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009[a].

Year	Adults (M,F)	Subadults (M,F)	Age Unknown (M,F)	Age Combined (M,F)	Juveniles[b]	Subadults (%)[c]	Males (%)
1990	54 (30,24)	2 (1,1)	96 (53,43)	152 (84,68)	26	4	55
1991	112 (58,54)	7 (3,4)	84 (46,38)	203 (107,96)	33	6	53
1992	139 (77,62)	8 (4,4)	97 (46,51)	244 (127,117)	121	5	52
1993	136 (76,60)	12 (5,7)	46 (24,22)	194 (105,89)	16	8	54
1994	139 (73,66)	11 (7,4)	31 (17,14)	181 (97,84)	66	7	54
1995	126 (64,62)	9 (7,2)	16 (12,4)	151 (83,68)	24	7	55
1996	123 (61,62)	5 (4,1)	17 (10,7)	145 (75,70)	46	4	52
1997	114 (63,51)	7 (2,5)	16 (9,7)	137 (74,63)	18	6	54
1998	133 (70,63)	4 (3,1)	22 (14,8)	159 (87,72)	45	3	55
1999	122 (71,51)	7 (1,6)	15 (9,6)	144 (81,63)	12	5	56
2000	111 (65,46)	10 (2,8)	22 (16,6)	143 (83,60)	59	8	58

cont.

Year	Adults (M,F)	Subadults (M,F)	Age Unknown (M,F)	Age Combined (M,F)	Juveniles[b]	Subadults (%)[c]	Males (%)
2001	151 (80,71)	10 (4,6)	25 (20,5)	186 (104,82)	18	6	56
2002	157 (86,71)	13 (5,8)	27 (17,10)	197 (108,89)	98	8	55
2003	168 (90,78)	13 (2,11)	21 (15,6)	202 (107,95)	39	7	53
2004	140 (71,69)	11 (5,6)	23 (15,8)	174 (91,83)	106	7	52
2005	157 (78,79)	19 (11,8)	30 (20,10)	206 (109,97)	32	11	53
2006	145 (78,67)	18 (9,9)	21 (13,8)	184 (100,84)	31	11	54
2007	151 (76,75)	7 (2,5)	20 (13,7)	178 (91,87)	67	4	51
2008	101 (55,46)	7 (2,5)	23 (13,10)	131 (70,61)	1	6	54
2009	115 (60,55)	2 (1,1)	15 (6,9)	132 (67,65)	49	2	51

[a]Owls where both age and sex were undetermined are not included in tabulation.
[b]Juvenile owl numbers represent the yearly total number of all young located.
[c]Known age owls only included in calculations

Table 4. Model ranking of the best logistic regression models on the annual sex representation by age class for northern spotted owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009.

Model	Deviance	AICc	Number of Parameters	ΔAIC	w_i
age class	3571.760	3576.761	2	0	0.426
age class, T[a]	3571.427	3578.428	3	1.667	0.185
age class, lnT[b]	3571.603	3578.605	3	1.844	0.169
age class, TT[c]	3570.875	3579.877	4	3.116	0.090
null	3577.583	3580.583	1	3.823	0.063

[a]T = Linear time trend
[b]lnT = Pseudo-threshold time trend [ln(T+0.05)]
[c]TT = Quadratic time trend (T + TT)

Nest Success

We checked 42 owl pairs for nesting success and 25 of those pairs nested. On average, 54% (SE = 5.52; min. = 3%; max = 86%) of pairs in the population have attempted to nest annually during the study. Prior to 2006 there was a tendency for high and low nesting on alternate years; the relatively high nesting observed in 2007 followed by the historically low nesting in 2008 but a switch in the odd-even year pattern may indicate a resumption of that cycle. There were 2 nesting pairs (8%) that failed to fledge young in 2009. Annually, the rate of nest failure has been approximately 17% (SE = 1.87, n = 20; min. = 0.0, max. = 26.9) (Figure 6).

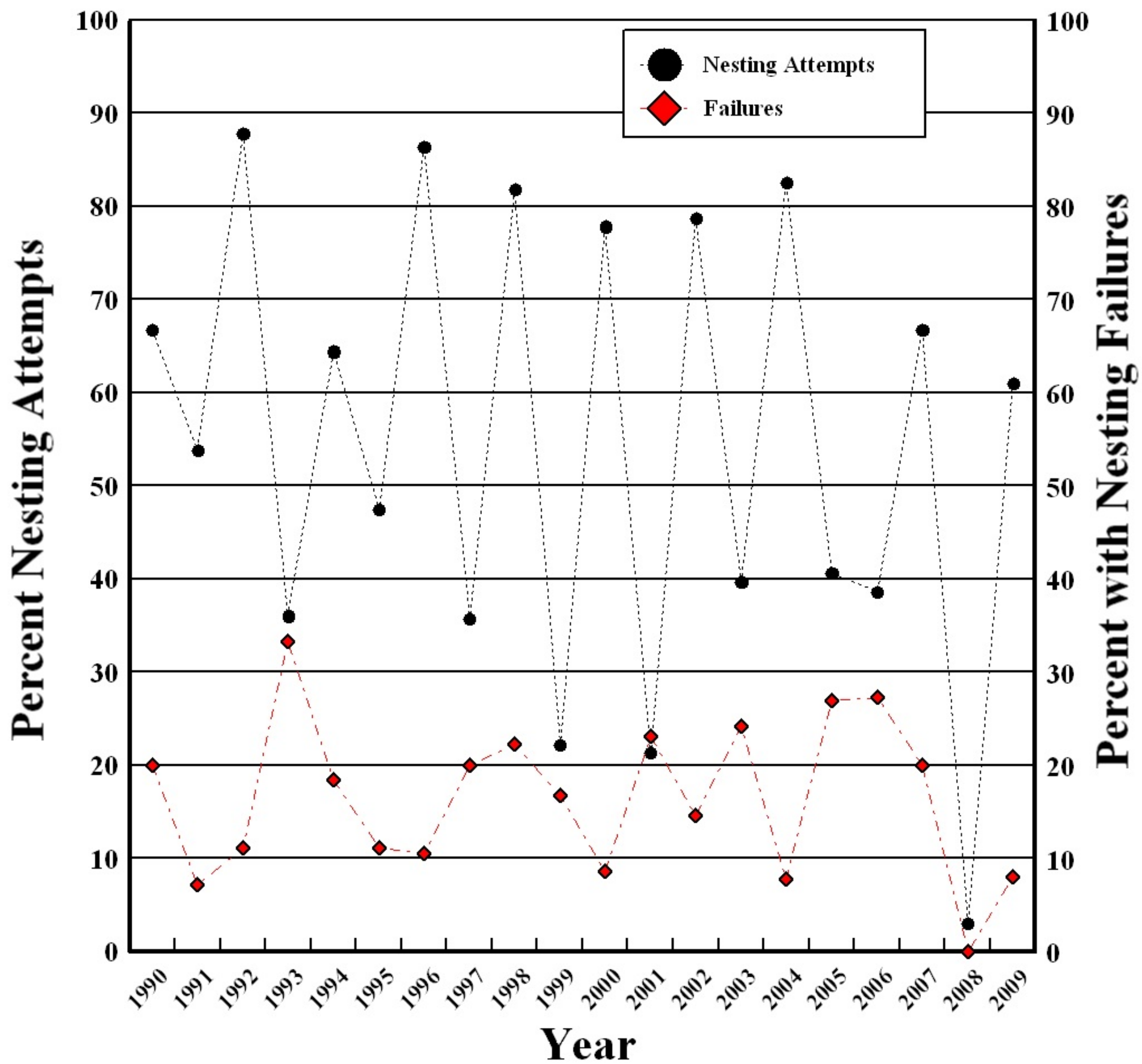

Figure 6. Percentages of northern spotted owl pairs attempting to nest and nesting failures on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009.

Reproductive Success

The number of young fledged per site for all occupied sites (0.89) was greater than the annual mean average for all years ($\bar{x}$ = 0.67, SE = 0.09, n = 20) (Figure 7). Of the occupied sites we checked for reproductive success in 2009, 53 pairs were located and 27 of these successfully reproduced ($\bar{x}$ = 25.9, SE = 3.55, n = 20; min. = 1; max. = 64). The number of pairs which have been located with young has varied annually following a pattern similar to nesting attempts. The number of young produced per successful pair (1.81) in 2009 was greater than the average during the study ($\bar{x}$ = 1.61, SE = 0.052, n = 20) (Table 5).

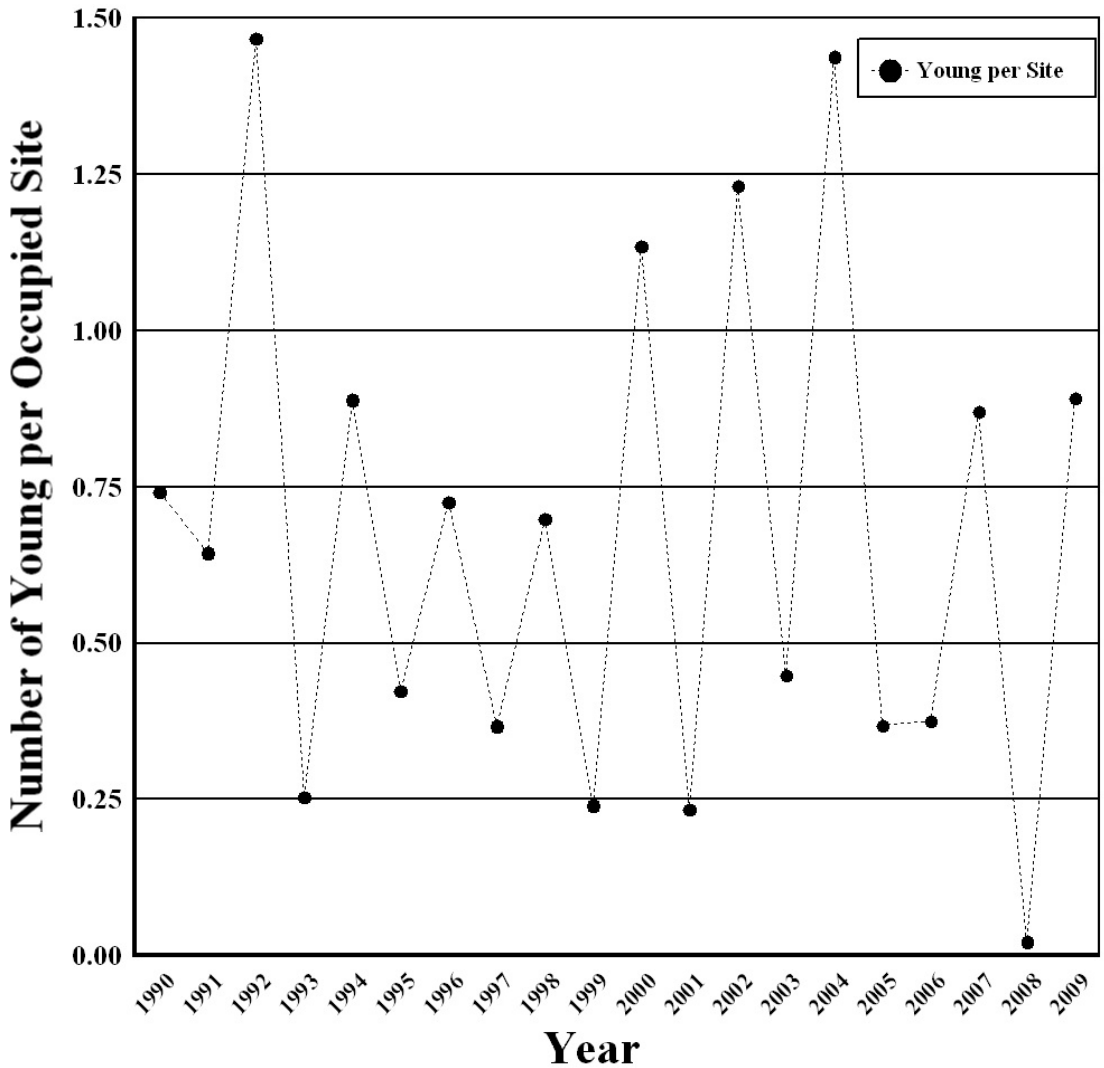

Figure 7. The number of young produced per total number of occupied sites that were surveyed for reproduction to protocol on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009.

Table 5. Summary of reproductive success of northern spotted owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009[a].

Year	# Pairs Checked	# Pairs Fledging Young	# Young Fledged	% Pairs Producing Young	Average # of Young/ Successful Pair	Average # of Young/Pair
1990	32	18	26	56	1.44	0.81
1991	44	17	26	39	1.53	0.59
1992	75	55	112	73	2.04	1.49
1993	58	11	16	19	1.45	0.28
1994	70	35	64	50	1.83	0.91
1995	46	14	22	30	1.57	0.48
1996	61	30	45	49	1.50	0.74
1997	46	12	18	26	1.50	0.39
1998	61	32	44	53	1.38	0.72
1999	50	7	12	14	1.71	0.24
2000	49	34	59	69	1.74	1.20
2001	76	11	18	15	1.64	0.24
2002	74	51	96	69	1.88	1.30
2003	82	23	39	28	1.70	0.48
2004	73	56	105	77	1.88	1.44
2005	80	23	31	29	1.35	0.39
2006	74	19	30	26	1.58	0.41
2007	74	41	67	55	1.63	0.91
2008	44	1	1	2	1.00	0.02
2009	53	27	49	51	1.81	0.92

[a] All sites which were surveyed to reproductive protocol (Forsman 1995).

An average of 0.81, 1.18 and 0.75 young were fledged per pair in LSR, Matrix and Wilderness areas in 2009, respectively. Between 1997 and 2009, the average number of young produced per pair in LSRs ($\bar{x}$ = 0.67, SE = 0.133, n = 13; min. = 0.04, max. = 1.40), Matrix ($\bar{x}$ = 0.70, SE = 0.111, n = 13; min. = 0.00, max. = 1.46) and Wilderness ($\bar{x}$ = 0.54, SE = 0.195, n = 11; min. = 0.0, max. = 1.67) areas has been similar (Table 6).

Average reproductive success in 2009 on the Rogue-Umpqua Divide LSR was 1.00 juveniles per pair ($\bar{x}$ = 0.73, SE = 0.158, n = 13; min. = 0.00, max. = 1.83). Owl pairs in the Middle Fork LSR fledged an average of 0.89 juveniles in 2009 ($\bar{x}$ = 0.68, SE = 0.148, n = 13; min. = 0.0, max. = 1.67). The average reproductive success of owl pairs in the Dead Indian LSR (0.38) was less than in most years ($\bar{x}$ = 0.59, SE = 0.116, n = 13; min. = 0.0, max. = 1.39).

Table 6. Summary of reproductive success for northern spotted owls, by Land-use Allocation, on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1997-2009[a].

LUA	Year	Number of Pairs Checked	Number of Pairs Fledging Young	Number of Young Fledged	Percentage of Pairs Producing Young	Average Number of Young/ Successful Pair	Average Number of Young/Pair	Mean Fecundity[b], # Females
Matrix								
	1997	17	6	9	35	1.50	0.53	0.264 (17)
	1998	16	10	13	63	1.30	0.81	0.375 (16)
	1999	15	6	10	40	1.67	0.67	0.333 (15)
	2000	14	7	11	50	1.57	0.79	0.393 (14)
	2001	20	4	6	20	1.50	0.30	0.143 (21)
	2002	22	12	24	55	2.00	1.09	0.545 (22)
	2003	23	6	11	26	1.83	0.48	0.229 (24)
	2004	22	18	32	82	1.78	1.46	0.659 (22)
	2005	28	8	10	29	1.25	0.36	0.167 (30)
	2006	22	6	10	27	1.67	0.46	0.217 (23)
	2007	20	11	19	55	1.72	0.95	0.452 (21)
	2008	14	0	0	0	0.00	0.00	0.000 (17)
	2009	17	11	20	65	1.82	1.18	0.556 (18)
LSR								
	1997	27	6	9	22	1.50	0.33	0.167 (27)
	1998	37	21	30	57	1.43	0.81	0.405 (37)
	1999	32	1	2	3	2.00	0.06	0.031 (32)
	2000	29	23	40	79	1.74	1.38	0.667 (30)
	2001	47	7	12	15	1.71	0.26	0.128 (47)
	2002	45	33	60	73	1.82	1.33	0.667 (45)
	2003	48	15	25	31	1.67	0.52	0.276 (49)
	2004	42	30	58	71	1.93	1.38	0.674 (43)
	2005	45	12	18	27	1.50	0.40	0.202 (47)
	2006	44	12	18	27	1.50	0.41	0.191 (47)
	2007	46	28	45	61	1.61	0.98	0.450 (50)
	2008	23	1	1	4	1.00	0.04	0.020 (25)
	2009	32	14	26	44	1.86	0.81	0.394 (33)

cont.

LUA	Year	Number of Pairs Checked	Number of Pairs Fledging Young	Number of Young Fledged	Percentage of Pairs Producing Young	Average Number of Young/ Successful Pair	Average Number of Young/Pair	Mean Fecundity[b], # Females
CRWA								
	1997	3	0	0	0	NA	0.00	0.000 (3)
	1998	8	2	2	25	1.00	0.25	0.125 (8)
	1999	3	0	0	0	NA	0.00	0.000 (3)
	2000	6	4	8	67	2.00	1.33	0.667 (6)
	2001	8	0	0	0	NA	0.00	0.000 (8)
	2002	7	6	12	86	2.00	1.71	0.857 (7)
	2003	11	2	3	18	1.50	0.27	0.125 (12)
	2004	9	9	15	100	1.67	1.66	0.833 (9)
	2005	7	3	3	43	1.00	0.43	0.188 (8)
	2006	8	1	2	13	2.00	0.25	0.143 (8)
	2007	8	2	3	25	1.50	0.38	0.188 (8)
	2008	6	0	0	0	0.00	0.00	0.000 (7)
	2009	6	2	3	50	1.50	0.75	0.375 (4)

[a] All sites which were surveyed to reproductive protocol (Forsman 1995).
[b] Average fecundity estimate = number of female young produced per female owl (assume a 1:1 sex ratio of young at birth).

The smaller LSRs had relatively greater fluctuations in the annual number of young fledged per pair, reflecting small sample sizes. In 2009 no owl pairs were located in either of the small LSRs.

The average fecundity recorded in 2009 (age classes combined) for the LSR was 0.39 ($\bar{x}$ = 0.33, SE = 0.065, n = 13, min. = 0.02, max. = 0.67), for the Matrix was 0.56 ($\bar{x}$ = 0.33, SE = 0.052, n = 13, min. = 0.00) and in the Wilderness was 0.38 per female ($\bar{x}$ = 0.27, SE = 0.087, n = 13, min. = 0.00, max. = 0.67) (Table 6). Over the course of the study annual female mean fecundity for spotted owl territories the LSR and Matrix have tended to be greater than for Wilderness sites. Average fecundity was 0.45 (SE = 0.065, n = 55) for all females in 2009 ($\bar{x}$ = 0.34, SE = 0.048, n = 19; min.= 0.01, max. = 0.74) (Figure 8). Average fecundity was 0.46 (SE = 0.066, n = 53) for adults and 0 for subadults.

Bandings/Re-observation

We banded 36 owls (26 fledglings, 1 subadult and 9 adults) on the study area in 2009, and there were a total of 103 non-juvenile owls of known identity in the sample, considerably more than in 2008 (90). The minimum average age for all males was 8.1 years (SE = 0.62, n = 61) and 7.4 years (SE = 0.51, n = 55) for all females. The minimum age of the oldest owl in the sample was at least 19 years of age. The minimum age of the oldest owls in the sample during the study appears to have reached an asymptote in the range of 16 to 19 years (Figure 9).

There were 12 documented major inter-territory movements of banded owls in 2009 that were associated with the demographic study. Two owls originally banded as juveniles (in 2002 and 2005) emigrated out of the study area and were relocated by other studies. Three owls originally banded as juveniles (two in 2004 and one in 2005), two as second-year subadults, and 5 as adults, were recaptured at new locations within the study area.

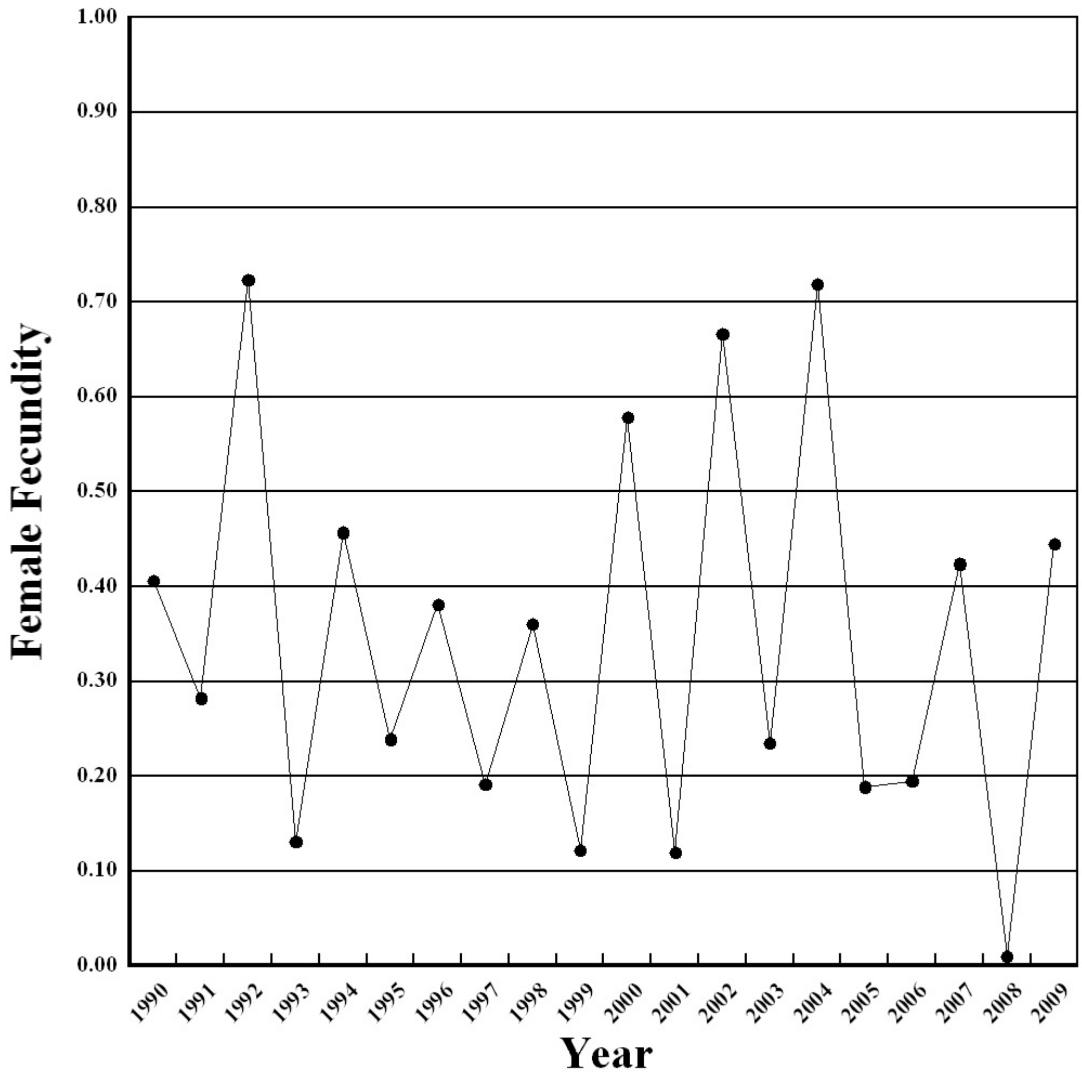

Figure 8. Mean annual fecundity for female owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1990-2009. Fecundity calculated as the mean number of young fledged per female checked for reproductive success divided by 2 and assuming a 1:1 sex ratio of young at birth.

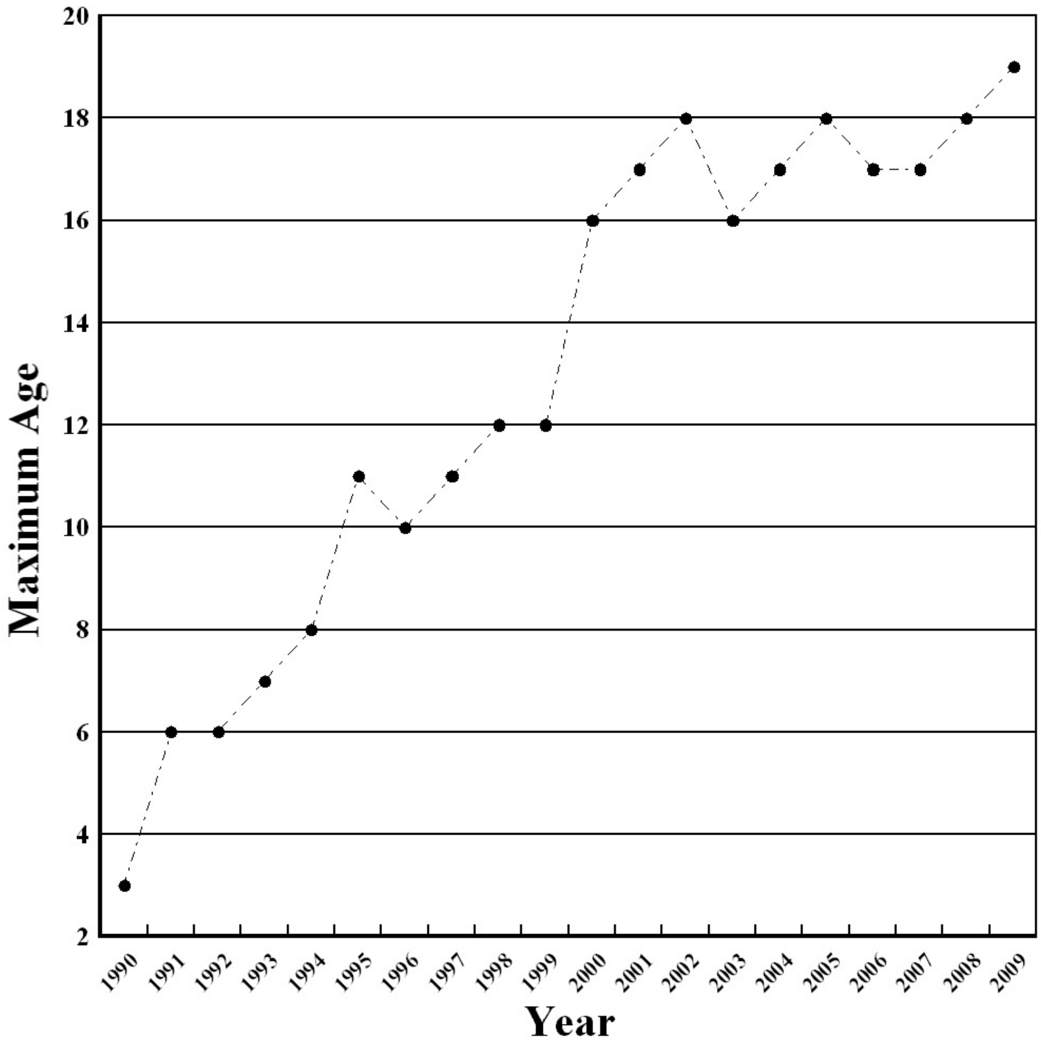

Figure 9. Estimated age of the oldest known spotted owl on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, 1990-2009.

A total of 226 movements have been recorded during the study. The mean movement distance was 23.0 km for females (SE = 1.849, n = 108; min. = 0.9, max. = 82.5) and 15.2 km (SE = 1.506, n = 119; min. = 0.8, max. = 93.2) for males. Modeling the binary data using logistic regression in PROC GENMOD (SAS Institute 2008) suggested there was evidence that dispersal distance for females was greater than for males [w_i = 0.399, 95% CI for distance = (-0.056, -0.014)], and there was some evidence that juvenile owls may disperse greater distances that non-juveniles but the 95% CI for age class parameter included 0 (-0.156, 1.167) in the best model. There was evidence of an interaction between age and dispersal distance relative to males and females but the coefficient for the parameter overlapped 0 [w_i = 0.137, 95% CI = (-0.0418, 0.0648). There was weak evidence of linear or pseudo-threshold time trends in dispersal distances, but the models were minimally competitive and the time coefficients broadly overlapped 0 [w_i = 0.131, 95% CI = (-0.049, 0.0664); w_i = 0.126, 95% CI = (-0.484, 0.469) (Akaike 1973, Burnham and Anderson

2002, Anderson 2008, SAS 2008) (Table 7).

Table 7. Model ranking of the best fit logistic regression models on the binary data of dispersal distance (km) by sex and age class over time for northern spotted owls on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1991-2009[a].

Model	Deviance	QAICc [a]	Number of Parameters	ΔQAIC	w_i
age class, distance	300.7481	272.8667	3	0.0000	0.344
distance	303.0400	272.8955	2	0.0289	0.339
age class * distance[b]	300.5629	274.7083	4	1.8417	0.137
age class, distance, T[c]	300.6611	274.7954	4	1.9288	0.131
age class, distance, lnT[d]	300.7472	274.8719	4	2.0053	0.126
age class, distance, TT[e]	300.3926	276.5650	5	3.6984	0.054
null	314.1556	280.7554	1	7.8888	0.007
age class	313.7532	282.4014	2	9.5350	0.003

[a] QAICc used to account for extra binomial variation; c^hat = 1.127
[b] Includes main effect terms
[c] lnT = Pseudo-threshold time trend [ln(T+0.05)]
[d] T = Linear time trend
[e] TT = Quadratic time trend (T + TT)

Barred Owls

The range of northern barred owls (*Strix varia*) has expanded during the last century and now overlaps that of northern spotted owls. Barred owls were first detected within the boundaries of the Southern Cascades Study Area in 1981. This study was not designed to systematically follow trends in barred owl occupancy but it has gathered a significant number of detections of barred owls during the course of spotted owl surveys. The annual percentage of historic spotted owl territories with barred owls has increased from 4.1 to 21.9% since 1991 (Figure 10).

Cumulatively, 56% of the sites have had at least one year and up to as many as 14 years with a barred owl detections (Figure 11). Detecting barred owls is problematic given the study design because some barred owls may be missed or may represent transient individuals detected during spotted owl surveys. Additional research using improved methodology is needed (i.e. barred owl calls) to evaluate and predict the effects of barred owl range expansion on spotted owls (Kelly et al. 2003, Forsman et al. 2009).

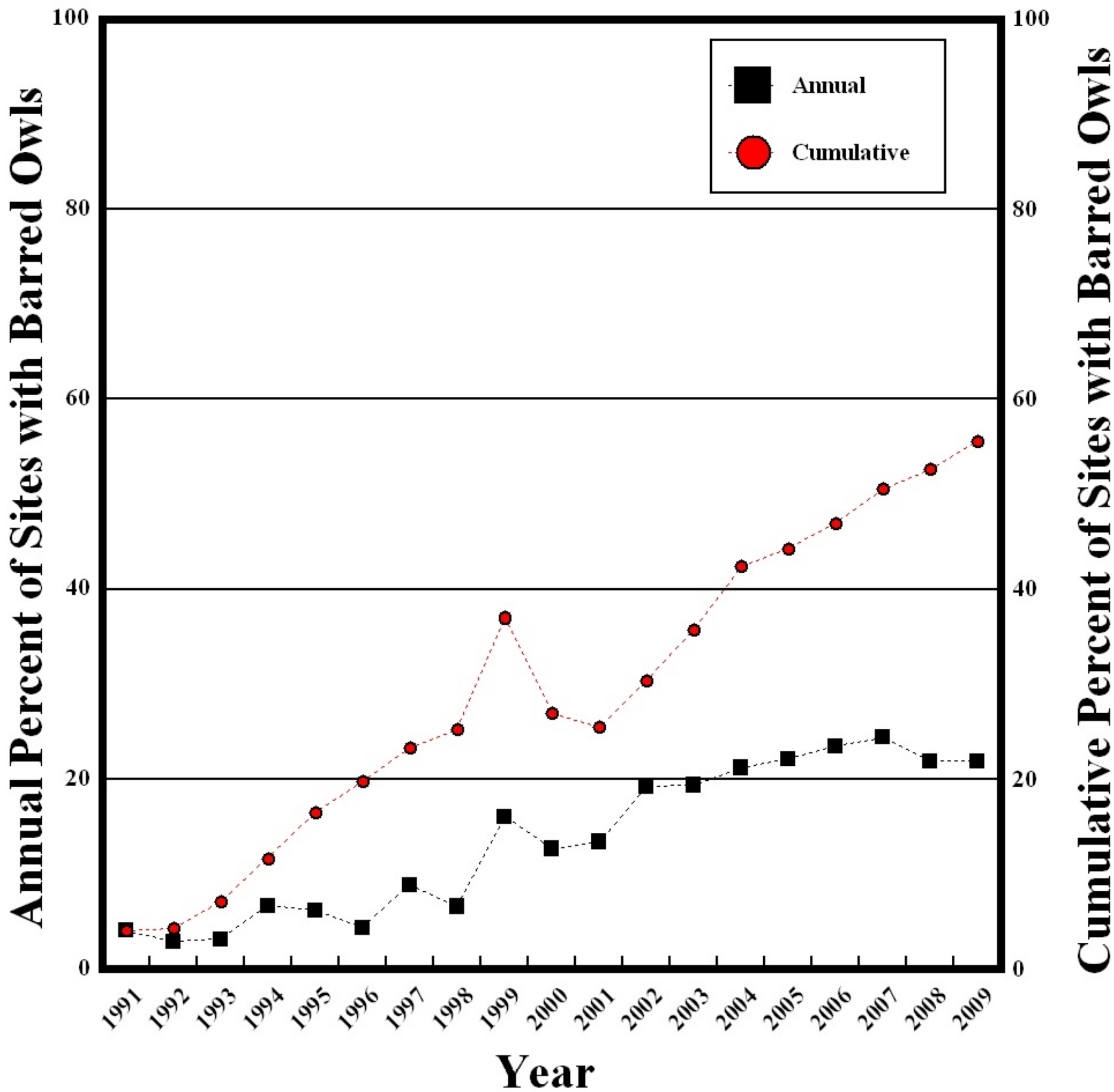

Figure 10. The annual percentages of historic spotted owl territories surveyed where barred owls were detected and cumulative spotted owl territories where barred owls were ever detected (fluctuations related to the annual number of areas sampled) on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 1991-2009.

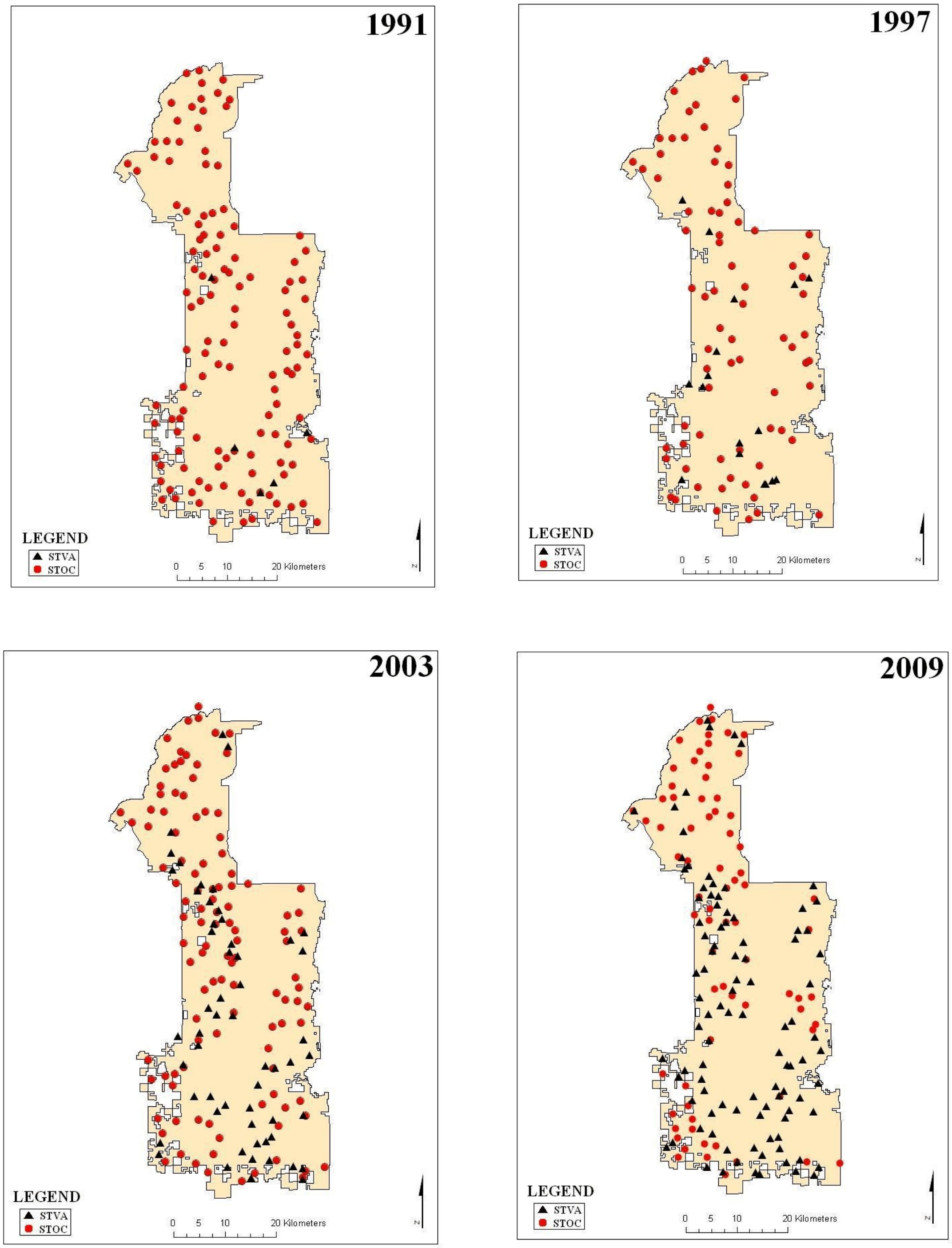

Figure 11. Annual spotted owl detections (STOC) and cumulative barred owl detections (STVA) for different years on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon.

Spotted Owl Diets

We initiated an analysis of northern spotted owl diets in 2000, and a total of 4,984 prey specimens from 123 owl sites in regurgitated pellets were collected and identified between 2000-2007. The sample consists primarily of northern flying squirrels (*Glaucomys sabrinus*) and woodrat species (*Neotoma cinerea* and *N. fuscipes*). Lagomorphs and pocket gophers (*Thomonys mazama and T. talpoides*) also comprised an important proportion of the prey biomass. Red-backed voles (*Clethrionomys californicus*) and moles (*Scapanus orarius* and *S. townsendii*) in pellets were low in biomass but higher in absolute numbers (Figure 12).

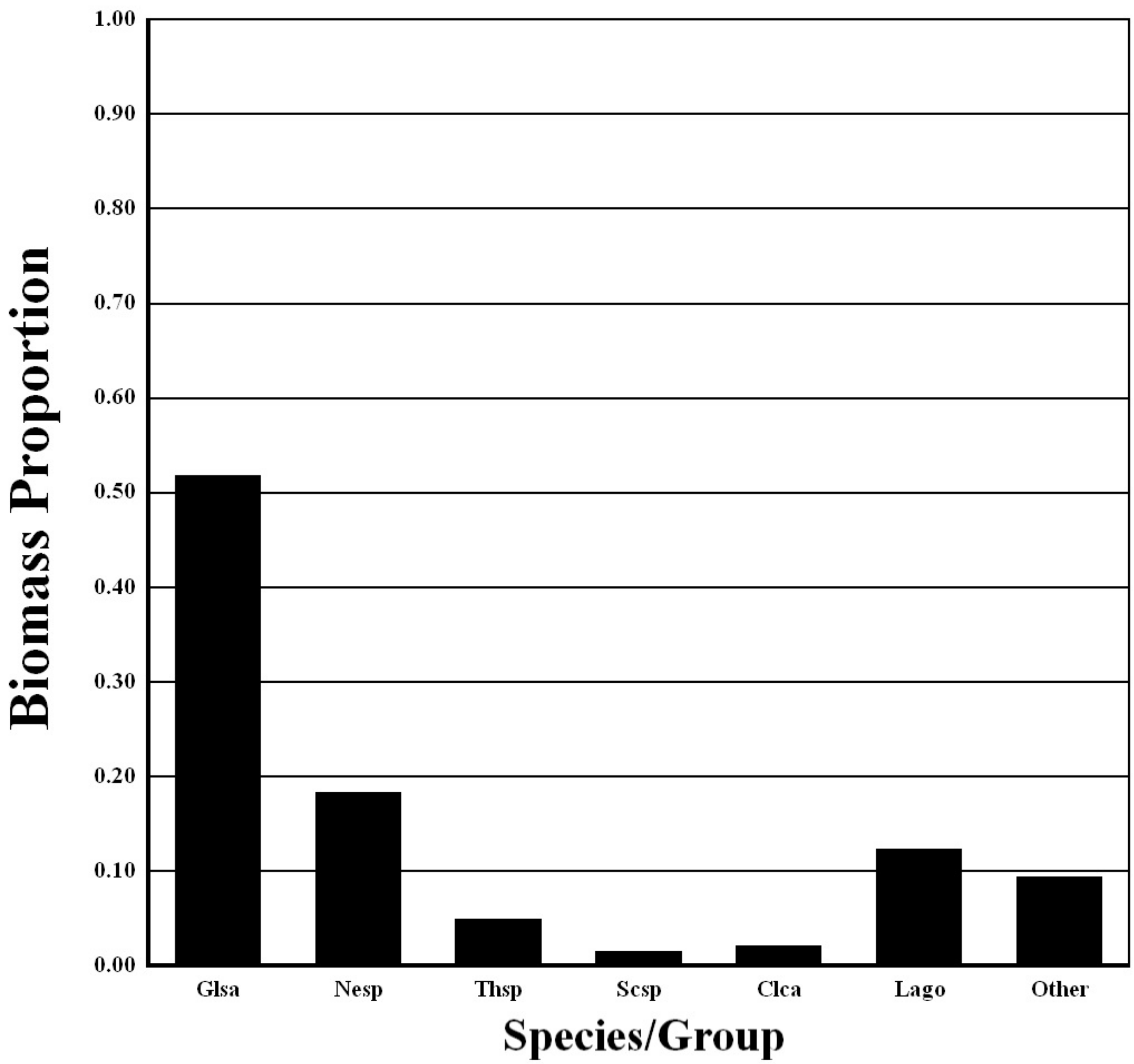

Figure 12. Biomass of prey items collected from spotted owl pellets on the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon, 2000-2007. Clca = *Clethrionomys californicus*, Glsa = *Glaucomys sabrinus*, Nesp = *Neotoma* species, Lago = Lagomorphs, Scsp = *Scapanus* species, Thsp. = *Thomomys* species.

Middle Fork Fire

In August 2008, fires from multiple lightning strikes, collectively referred to as the Lonesome Complex, culminated in a large wildfire originating in the Middle Fork of the Rogue River. The Middle Fork fire affected approximately 8,540 ha in a mixed severity wildfire mosaic. The Middle Fork fire affected 8 historic owl territories within the boundaries of the Southern Oregon Cascades Study Area, and 4 of the sites were occupied by spotted owls in 2008. The sites were revisited in 2009, and spotted owl pairs were relocated with no young at 3 territories (Figure 13). We plan to monitor these sites closely in the coming years in order to document any changes in spotted owl occupancy and reproduction that may be associated with the fire.

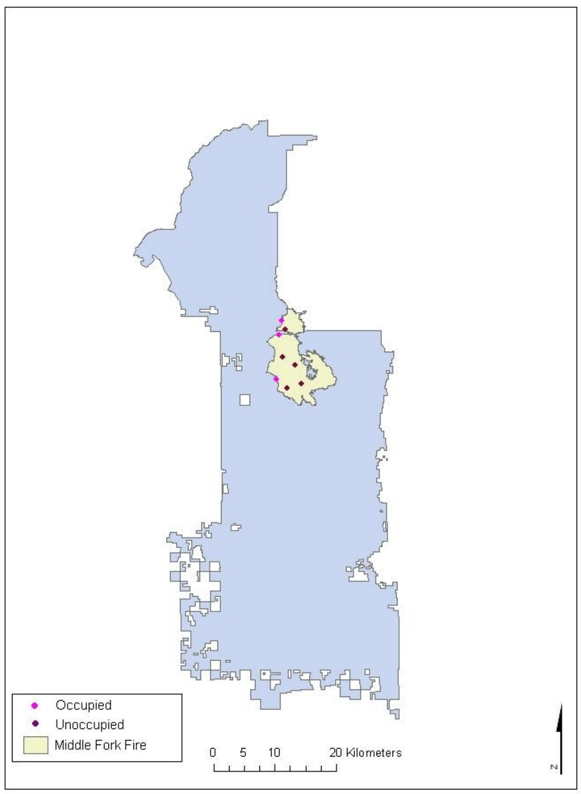

Figure 13. Middle Fork Fire boundary and associated spotted owl territories in the Southern Cascades Study Area, Rogue River-Siskiyou and Fremont-Winema National Forests, Oregon.

Apparent Survival, Fecundity, and Population Trend

A workshop was conducted to analyze range-wide demographic data of northern spotted owls in January 2009 (Forsman et al. 2010). The workshop was held as a requirement of the *Northern Spotted Owl Effectiveness Monitoring Plan for the Northwest Forest Plan* (Lint et al. 1999). It was the fourth in a series of demographic workshops that have been convened every five years since 1993. Fecundity, apparent survival, and population trend were estimated for the Southern Oregon Cascades Study Area, including spotted owls in Crater Lake National Park and Lakeview BLM District. This workshop expanded on the scope of previous meta-analyses by incorporating habitat and climatic/weather covariates. Additionally, the annual rate of population change [lambda (λ)] was estimated as separate survival and recruitment components.

Prior to the beginning of the workshop, a session was convened to establish a standardized protocol and analysis methodology following the guidelines in Anderson et al. 1999. The participants agreed to an *a priori* suite of models to be examined based on the biology of spotted owls and previous research. Survival and fecundity were estimated for all owls where sufficient data were available from 1991 to 2008. Population trend (λ) was analyzed on a sub-sample of the survival data set. Lambda was estimated for owls from a fixed group of owl territories. The population modeling permitted a one-time addition of sites to the original data set to accommodate increases in size for the study area. We modeled λ for 105 sites in the southern Cascades beginning in 1992 and added 57 additional sites to the sample in 2001.

A suite of 44 models using Cormack-Jolly-Seber (CJS) estimators in program MARK was used to investigate age-specific apparent survival with time-trends for 555 non-juvenile spotted owls (Table 6) (White and Burnham 1999). Model selection was conducted using QAIC, a modification of Akaike's Information Criteria, to adjust for overdispersion (extra binomial variation) in the capture-recapture data (Akaike 1973, Burnham and Anderson 2002). The best fit model for survival, { ((S1=S2,A)+TT) p(t)}, indicated that there were no sex related differences but that subadult survival differed from adult owls; survival exhibited a quadratic time trend and detection probability varied annually. However, six models were all within 2.0 ΔQAIC of each other indicating there was support for competing models (Table 8). Mean apparent annual survival was estimated using model averaging as 0.692/0.697 for first year subadults, 0.733/0.737 for second year subadults and 0.851/0.853 for adults (female/male, respectively). Overall, apparent annual survival appears to be declining in the Southern Oregon Cascades, and this decline accelerated between 2003-2008. Modeling indicated that neither the proportion of barred owls detected on the study area (β = 1.657, SE = 0.878, 95%CI = -0.062, 3.378) or reproduction (β = -0.129, SE = 0.194, 95%CI = -0.509, 0.252) appeared to influence spotted owl survival.

Annual fecundity was estimated for 1,281 paired females from 1991 to 2008. PROC MIXED in program SAS (SAS Institute 2008) was used to generate age-specific estimates of fecundity. The best fit model {A+EO+ENT+HAB1} incorporated a three age-class effect, a odd-even year effect associated, and increasing productivity associated with both higher early nesting season temperature and greater percentages of suitable habitat within a 2.4 km radius of the annual site center. There were no competing models within 2.0 ΔQAIC. The fecundity estimate for adult females was 0.35 (SE = 0.052, n =1,176), 0.21 (SE = 0.064, n = 68) for 2-year-old subadult females, and 0.06 (SE = 0.038, n = 37) for 1-year-old subadult females. The regression coefficient was negative (β = -0.015, SE = 0.005) for the best model containing a time trend {A + EO +T}, and the 95% confidence interval did not overlap zero (-0.026, -0.004) which indicated that fecundity for the southern Cascades was declining during the study years. The best model containing a barred owl effect {A + EO + BO} was not within 2.0 ΔQAIC, but the regression coefficient was negative (β = -0.972, SE = 0.387) and the 95% CI did not include 0 (-1.752 to -0.193) indicating that lower spotted owl fecundity was associated with barred owl detections in the study area.

Table 8. Model ranking of the top 6 survival models within 2.0 ΔQAIC for non-juvenile northern spotted owls in the Southern Cascades Study Area, Oregon, 1991-2008[a].

Model	Deviance	QAICc	ΔQAICc	K	w_i
{φ([(S1=S2)+A]+T+TT) *p*(t)}	1805.402	4185.395	0.0000	21	0.15212
{φ([(S1=S2)+A]+T+TT) *p*(s+t)}	1804.120	4186.151	0.7563	22	0.10422
{φ([(S1+ S2+A]+T+TT) *p*(t)}	1804.508	4186.539	1.1444	22	0.08584
{φ([(S1= S2)+A]+s+T+TT) *p*(t)}	1804.898	4186.929	1.5340	22	0.07065
{φ([(S1+S2+A]+T+TT) *p*(s+t)}	1803.231	4187.301	1.9064	23	0.05864
{φ([(S1 = S2)+A]+cubic spline) *p*(t)}	1803.319	4187.389	1.9945	23	0.05612

Lambda was estimated with a reparameterized Jolly-Seber (RJS) method in program MARK using capture-recapture data from 526 non-juvenile spotted owls (Pradel 1996, Nichols and Hines 2002). The best model for the southern Cascades {(φ(t) *p*(t) *f*(t)):RE(.)} included constant random effects and the results suggest that the population was stationary during the period of the study. Lambda was estimated to be 0.982 (SE = 0.030) for the southern Cascades; 95% CI (0.923, 1.040). The survival component of λ showed substantial temporal variation which indicated that it played an important role in fluctuations of λ in the southern Oregon Cascades. The annual realized rate of population change ($\Delta\lambda$) exhibited annual fluctuation and broadly overlapped 0 suggesting the population was stable.

For additional information regarding the methodology and results of the 2009 meta-analysis please see Forsman et al. 2010.

Discussion

Precipitation and snowpack in the south Cascades was approximately average in the 2009 field season. Our access to sites and survey effectiveness was similar to most years of the study. This likely minimized temporal variation in our assessments of occupancy, productivity and survival relative to most preceding field seasons.

In 2009 nesting attempts, productivity and the total number of known identity owls increased compared to 2008. There were fewer sites where social status was undetermined than the previous year, and this may account at least in part for the increase in the number of sites occupied by pairs compared to the previous year. The total percentage of occupied sites (44), however, was the lowest recorded for the study and represented a 33% decrease since 2005.

Through the course of the study productivity has followed a strong biannual pattern of alternating high and low years, which was disrupted by low productivity in both 2005 and 2006. The 2009 breeding season was similar to the 2007 breeding season relative to the number of juveniles fledged per pair. However, the total number of pairs checked has decreased during the last 4 years and was approximately 70% of the number in 2005.

The 2009 workshop and additional analyses can be synthesized in a review of the information specific to the southern Oregon Cascades. Apparent declines in the number of spotted owls has been attributed to a different spatial and temporal factors including habitat loss and competition by barred owls (USDI 2008). On the Southern Cascades Study Area, the proportion of historic spotted owl territories where barred owls were located in 2009 was similar to 2008; however, the cumulative total of sites with barred owls increased by approximately 3%. Since our surveys do not target barred owls specifically there may be more sites occupied by barred owls than we identified, and conversely spotted owls may have gone undetected where barred owls were present. Dugger et al. 2009 conducted an occupancy analysis for a subset of spotted owl territories within the study area during the time frame from 1991 and 2006. The study found that the presence of barred owls at a specific site reduced spotted owl detectability, increased the probability of spotted owl site extinction and decreased site recolonization probability. In the meta-analysis the best models incorporating a barred owl covariate indicated a decrease in survival and fecundity as the proportion of sites with barred owls increased. In the meta-analysis the proportion of historic spotted owl territories with barred owl detections was associated with lower spotted owl fecundity (Forsman et al. 2010).

Habitat did not appear to influence spotted owl survival and fecundity on the Southern Oregon Cascades study area between 1991-2003 (Dugger et. al. 2006); however, the amount of older forest surrounding spotted owl annual core areas was associated with increased survival and fecundity at the workshop (Forsman et al. 2010). Greater amounts of habitat in owl cores as well as reduced fragmentation are associated with increased recolonization rates and reduced extinction rates of spotted owl territories within the study (Dugger et al. 2009). It is noteworthy that in the two analyses different methods were used to characterize and identify suitable habitat. A range-wide habitat suitability map for northern spotted owls is being developed for use in future efforts to rectify this situation.

Climatic and weather effects in the southern Cascades were incorporated in the analyses by Dugger et al. (2006), Glenn (2009) and in the 2008 meta-analysis (Forsman et al. 2010). Dugger et al. 2006 found that early nesting season precipitation tended to reduce productivity on the west side of the Cascades. Glenn (2009) found a quadratic relationship between annual precipitation and productivity where the number of young fledged decreased following years of less than or greater than than normal precipitation. Forsman et al. (2010) found increasing productivity associated with higher early nesting season temperatures. Dugger et al. 2006 and Forsman et al. 2010 found no relationship between survival and climate. In contrast, Glenn (2009) found that annual survival was positively associated with higher winter temperatures and years with average winter storm frequency but negatively associated with the number of days with temperatures >90ºF (Glenn 2009). Glenn (2009) analyzed λ using separate survival and recruitment components relative to climate and found that survival was negatively associated the number of days with temperatures >90ºF and that recruitment was highest two years following years with higher than average precipitation.

9. Acknowledgments:

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10. Research Plans for FY 2010:

a. Continue the demographic study, including stratification of owl sites by Land-use Allocation.

b. Continue the collection of pellets and analysis of spotted owl diets.

c. Continue the collection of data on northern spotted owl nest trees/nest sites.

d. Continue to assist personnel from Crater Lake National Park with their banding program.

11. Technology Transfer Completed in FY 2009:

a. R.G. Anthony (workshop coordinator) and S. Andrews participated in a workshop to conduct a range-wide meta-analysis of northern spotted owl demography held in January 2009, Corvallis, OR.

b. R.G. Anthony and S. Andrews participated in data coordination efforts with personnel from other demographic studies.

c. Project personnel provided the USDA-USFS Ranger Districts, USDI-BLM Resource Areas, and USDI-Crater Lake National Park with information in preparation of the meta-analysis workshop and have coordinated surveys.

12. Duration of the Study:

a. Initiated in 1990.

b. This project is part of the long-term Northern Spotted Owl Effectiveness Monitoring Program for the Northwest Forest Plan (Lint et al. 1999).

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